Chapter 3

Approach to Impact Assessment and Development of Conservation Measures to Avoid, Minimize, and Compensate for Impacts

3.1 Baseline for Endangered Species Act Consultation

Under baseline conditions for ESA consultation, the temporary barriers will continue to be constructed annually in the south Delta channels, and no new construction activities will be implemented. The head of Old River barrier and barriers in Middle River, Grant Line Canal, and Old River will be constructed every year, as they have been in the past. Construction of the temporary barriers includes grading the channel bank and placing riprap and other materials on the channel bank and bottom.

Various permit conditions are placed on the existing Temporary Barriers Program. Table 3-1 shows the specific permits and their issuing agencies.

During the spring barrier installation period, April 7 is the earliest that in-water construction activities can be conducted on the head of Old River, Middle River, and Old River at DMC barriers. April 1 is the earliest that construction can begin on the northern abutment and boat ramps of the Grant Line Canal barrier and the out-of-water portions of the head of Old River, Middle River, and Old River at DMC barriers. Full closure of the Grant Line Canal barrier is not required, but construction of the northern abutment and boat ramps must be completed to the extent that full barrier closure and operation can be readily achieved in a reasonable time frame when directed by DWR. The permit conditions require that all the above work be completed by April 15, a total of 15 working days.

Table 3-1. Temporary Barriers Program Permits

Permit	Permitting Agency	Project Description	Permit Number	Permit Date
404	U.S. Army Corps of Engineers	Spring and fall barriers at the head of Old River	200000696	April 11, 2001
404	U.S. Army Corps of Engineers	Barriers on GLC, MR and OR at DMC	200100121	April 18, 2001
Biological Opinion	U.S. Fish and Wildlife Service	Temporary barriers	1-1-01-F-81	March 30, 2001
Biological Opinion	National Oceanic and Atmospheric Administration, National Marine Fisheries Service	Temporary barriers	SWR-00-SA-289:MEA	April 5, 2001
401	Regional Water Quality Control Board	Temporary barriers		February 12, 2001
1601	California Department of Fish and Game	Barriers on GLC, MR, and OR at DMC	BD-2001-0001	March 29, 2001
1601	California Department of Fish and Game	Spring and fall barriers at the head of Old River	II-081-00	March 17, 2000
2081	California Department of Fish and Game	Temporary barriers	2081-2001-009-BD (Incidental Take Permit)	April 4, 2001

Construction activities associated with temporary barrier construction remove, disturb, modify, and replace channel bottom and channel bank substrates. Although annual activities are unlikely to remove or disturb substantial aquatic and riparian vegetation, reestablishment of vegetation is prevented in the footprint of the barriers. Organisms on the channel bottom and bank may be removed or crushed during grading and placement of riprap. Local noise, physical movement, and vibration may cause temporary movement of individuals or permanent loss of nestlings from adjacent habitat.

During temporary barrier construction, petroleum products associated with construction equipment may be spilled, and sediment may become suspended. These contaminants may adversely affect organisms in the channel, causing mortality from acute toxicity and suffocation of fish eggs and sessile organisms.

The placement of the barriers on Middle River, Grant Line Canal, and Old River maintains the water surface elevation above 1.0 foot msl during May–September. Under current conditions, tides range from about –1.0 to +3.0 feet msl twice each day. The placement of the barriers blocks fish access when tidal stage is below 1.0 foot msl, although access is maintained when tidal stage exceeds 1.0 foot msl (i.e., between 1.0 and 3.0 feet msl). The volume of water exchanged during each tidal cycle (i.e., between the high and the low tidal stage) is reduced by about 50% in the channels upstream of the barriers on Middle River, Grant Line Canal, and Old River. Impacts on water quality have not been documented. The barriers on Middle River, Grant Line Canal, and Old River may also be in place in April to mid-May and in October and November, although the culverts on the Grant Line Canal barrier are tied open.

The head of Old River barrier minimizes movement of juvenile fall-run Chinook salmon from the San Joaquin River into Old River from about April 14 to June 1. Instead, juvenile Chinook salmon and Central Valley steelhead move down the San Joaquin River past Stockton, a pathway believed to enhance survival relative to movement into Old River (Brandes and McLain 2001).

The head of Old River barrier increases flow in the San Joaquin River past Stockton from about September 15 to November 30. The increased flow in the San Joaquin River potentially improves water quality, including increased DO, in the San Joaquin River channel near Stockton (Giulianotti et al. 2003). Improved water quality could benefit upstream-migrating adult Chinook salmon.

3.2 Impact Mechanisms

Impact mechanisms are those actions affecting biological resources in the SDIP study area. Impact mechanisms can be direct, indirect, or cumulative. Direct and indirect impacts on ASIP-covered species and natural communities are assessed in Chapters 4 and 5. Cumulative impacts are assessed in Chapter 5.

Direct impacts for the SDIP include ground-disturbing activities, channel- and channel bed–disturbing activities associated with gate construction, and dredging. Gate construction and dredging activities have the potential to affect habitat for ASIP-covered species and natural communities. Direct impacts also occur as a result of gate operations (e.g., water level changes). Direct impacts can be either permanent or temporary (impacts that last less than 1 year).

Indirect impacts, as defined by the USFWS, are “those that are caused by the proposed action and are later in time, but are still reasonably certain to occur” (50 CFR 402.02). Examples of indirect impacts would be the introduction of a new predator into an area as result of a project’s implementation or erosion that occurs later in time as a result of gate construction or channel dredging.

Cumulative effects (impacts), as defined by the USFWS, “include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.” (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998.)

The following sections describe the impact mechanisms and affected environmental conditions for the SDIP project elements, including gate construction and operation and channel dredging. The changes in environmental conditions described here are the basis for the assessment of impacts on ASIP-covered species and natural communities, which are described in Chapters 4 and 5.

The assessment of impacts considers the occurrence and potential occurrence of species relative to the magnitude, timing, frequency, and duration of project activities, including construction and operation of gates in the south Delta, dredging, and water supply operations. The assessment links project actions to changes in environmental correlates, where environmental correlates are environmental conditions or suites of environmental conditions that individually or synergistically affect the survival, growth, fecundity, or movement of an ASIP-covered species.

Impacts potentially result from changes in environmental correlates caused by SDIP construction and dredging elements. This ASIP includes an assessment of the affects of gate operation (i.e., opening and closing the gates). The affects of water supply operation related to the SDIP are covered under the OCAP BO and therefore are not included in this ASIP. Changes in each environmental correlate are evaluated relative to potential impacts on the abundance and distribution of the ASIP-covered species. In particular, permanent changes in environmental correlates are assessed for the potential to measurably reduce the average abundance of a population over a range of weather-related conditions, especially during drier year types when environmental conditions may already be deficient, and for the potential to permanently limit the geographic range and the seasonal timing of any life stage.

3.3 Methods to Assess Project-Related Impacts

The following section describes the methods used to assess project-related impacts on ASIP-covered species and natural communities.

3.3.1 Gate Operations

The operation of the SDIP (both tidal gates and increased CCF diversions) was described and analyzed in the OCAP and has been authorized in the OCAP BOs issued by USFWS in February 2005, and in the BO issued by NOAA Fisheries in October 2004. This document evaluates the direct and indirect impacts associated with the tidal gate operations. The possible effects of increased SWP diversions will be evaluated in Stage 2 of the SDIP.

The following information on stage and water quality impacts is provided as background information for the reviewer.

3.3.1.1 Stage

Variations in stage could affect ASIP-covered plant species. Variations in stage are not expected to affect ASIP-covered fish or wildlife species.

Figures 3-1 and 3-2 identify the geographic area and elevational zones affected by changes in stage.

- The minimum stage for existing conditions is about –1.0 foot msl during the winter when the temporary barriers are removed and about 1.0 foot msl during the summer when the barriers are installed with a crest elevation of 1.0 foot msl. The minimum stage that would result from the implementation of the SDIP is 0.0 feet msl because the gates would ensure this water level.
- The median stage for existing conditions is about 1.0 foot msl during the winter and about 1.5 feet msl during the summer. The median stage resulting from the implementation of the SDIP is about 1.0 foot throughout the year.
- The maximum stage for existing conditions is about 3.0 feet msl. The maximum stage resulting from implementation of the SDIP is similar, although in a few months the maximum stage was reduced to 2.0 feet msl. The last 5 years of the 16-year study period (1987–1991) show the clearest differences between the existing conditions and the SDIP because there were no high San Joaquin River flows to complicate the tidal stage comparison.

During the winter, the overall range of tidal stage in the south Delta channels downstream of the gate sites could be reduced from about 4 feet to about 3 feet with implementation of the SDIP. This reduction will occur because the tidal gates will be operated to maintain a minimum stage of 0.0 feet msl throughout the year. During the summer, the overall range of tidal stage upstream of the gate sites could be increased from about 2 feet to 3 feet with implementation of the SDIP. This increase will occur because the temporary barriers will be operated with a higher crest elevation than the tidal gates.

3.3.1.2 Water Quality

The salinity impacts from the SDIP are generally measured by electrical conductivity (EC) changes and are not related to changes in Delta outflow that are generally regulated during low-flow periods when higher salinity is likely. The SDIP pumping changes will not allow salinity to increase above water quality objectives and will not allow salinity to increase as a result of substantially lower Delta outflow. In addition, the SDIP would comply with the D-1641 regulations.

There are four sources of water (and salinity) in the south Delta. Agricultural drainage and water from the San Joaquin River generally contribute the highest EC. Old River and Middle River contribute the remainder of the water and EC.

The Vernalis EC values have a strong influence on south Delta channel EC values because most San Joaquin River flow is diverted into the south Delta channels at the head of Old River. Control gate operations can provide more net flows from Victoria Canal into Middle River and from Old River at Clifton Court Ferry into the Old River channel upstream of the CVP Tracy facility. This increase in net flows will lower the EC values of the western portion of these south Delta channels.

The head of Old River gate, however, has the greatest potential to reduce salinity in the south Delta channels to a level that approaches the EC of the SWP export levels by reducing the amount of water entering the Old River from the San Joaquin River. This potential improvement in EC will be one of the objectives for the adaptive management of the south Delta control gates. The potential reduction in EC can be estimated as the difference between the San Joaquin River EC value and the EC value of the SWP exports. The EC value of SWP exports is normally between 500 and 750 microSiemens per centimeter (µS/cm) during the irrigation season. The Vernalis EC value is expected to be slightly less than the 700-µS/cm objective during the irrigation season. There is no reason to suspect that the south Delta channels will have EC values substantially higher than the Vernalis EC value. Comparison of the historical data suggests that the increase in EC values from Vernalis to Brandt Bridge is less than 100 µS/cm during low-flow summer periods and is much less at other times. Therefore, the maximum improvement in south Delta salinity would likely be less than 200 µS/cm. Achieving this improvement would require both that the head of Old River control gate be closed most of the time and that the Old River and Middle River control gates be operated to provide maximum tidal circulation.

3.3.1.3 Yield

Table 3-2 below shows the expected yield from the project in both 2001 and 2020.

Table 3-2. 73-Year Average Change in Delivery = Yield (thousand acre-feet)

	SDIP	
Delivery	2001	2020
SWP Firm	20	39
SWP Article 21 (Transfers)	59	50
CVP	107	101

SWP = State Water Project.
CVP = Central Valley Project.

3.3.2 Construction-Related Impacts

Construction-related impacts occur during gate construction activities and include long-term changes to environmental conditions that result from modification of habitat types (e.g., wetland, riparian). Construction activities include gate construction, operation, and maintenance; channel dredging; and deposition of dredge material at off-channel disposal sites.

3.3.2.1 Gate Construction and Operations

Construction of the gates under the SDIP potentially affects environmental conditions in the south Delta (Table 3-3). Permanent gates will be constructed at the head of Old River and in Middle River, Grant Line Canal, and Old River. Construction of the gates includes grading the channel bank, dredging the channel bottom, driving sheetpiles and H-piles, and placing riprap, concrete, and other materials on the channel bank and bottom.

Construction in the channel and dredging in Middle River, Grant Line Canal, and Old River to the east of the CVP intake will occur between August 1 and November 30 to minimize impacts on delta smelt and juvenile salmonids. In-channel dredging in West Canal will occur between August 1 and November 30 to minimize potential impacts on juvenile winter-run Chinook salmon and delta smelt.

Activities occurring in upland areas or on portions of the gates that are above the ordinary high-water mark will occur throughout the year, in accordance with restrictions or mitigation measures identified in the various environmental commitments (e.g., stormwater pollution prevention plan).

The construction activities will remove, disturb, modify, and replace channel bottom and channel bank substrates. Aquatic and riparian vegetation will be removed within the footprint of the gate and the footprint of riprap along the contiguous levee face and channel bottom. Organisms on the channel bottom and bank will be removed or crushed during grading, dredging, and placement of riprap and other materials. Local noise, physical movement, and vibration may cause temporary movement of individuals or permanent loss of nestlings from adjacent habitat.

During gate construction, petroleum products associated with construction equipment may be spilled, and sediment may become suspended. Contaminants introduced into the channel, including suspended sediment, may adversely affect organisms, causing mortality from acute toxicity and suffocation of fish eggs and sessile organisms.

The operation of the permanent agricultural gates on Middle River, Grant Line Canal, and Old River would maintain the water surface elevation above 0.0 feet msl from April 1 to September 30 or during other periods, as determined by the USFWS, NOAA Fisheries, and DFG. Under current conditions, tides range from about –1.0 foot to +3.0 feet msl twice a day. Closure of the agricultural gates would temporarily block fish access. The Middle River and Old River at DMC gates will generally be closed at high tides, and remain closed during ebb-tide periods. Fish access is maintained when the gate is opened at a tidal stage exceeding 0.0 feet msl (i.e., gates are open during flood tide periods when the downstream stage is greater than the upstream stage). The volume of water exchanged during each tidal cycle is reduced by about 20%, compared to conditions without gates, for the channels upstream of the gates on Middle River, Grant Line Canal, and Old River.

The head of Old River gate would block flow and movement of juvenile fall-/late fall–run Chinook salmon and other fishes from the San Joaquin River into Old River from about April 1 to June 1 or during other periods, as determined by the USFWS, NOAA Fisheries, and DFG. Instead, juvenile Chinook salmon would move down the San Joaquin River past Stockton, a pathway believed to enhance survival relative to movement into Old River (Brandes and McLain 2001).

The head of Old River gate would increase flow in the San Joaquin River past Stockton from about October 1 to November 30 or during other periods, as determined by the USFWS, NOAA Fisheries, and DFG. About 10–15% of the San Joaquin River flow would be allowed into Old River during this fall period. The increased flow in the San Joaquin River potentially improves water quality, including increased DO, in the San Joaquin River channel near Stockton (Giulianotti et al. 2003). Improved water quality could benefit upstream-migrating adult Chinook salmon.

Water temperature conditions in the south Delta appear to be unaffected by changes in gate operation, as indicated by measurements with the temporary barriers. For all months of the year, measured water temperature at Mossdale during 2000 and 2001 is nearly identical to the measured water temperature in Old River, Middle River, and the San Joaquin River near Stockton (Jones & Stokes 2005). Water temperature in the Delta is primarily determined by weather conditions; therefore, impacts of water temperature on fish species in the Delta are not discussed further.

3.3.2.2 Channel Dredging

In addition to the dredging associated with gate construction, dredging is proposed in West Canal, Old River, and Middle River. Dredging will remove and disturb the channel bottom. Aquatic vegetation will be removed within the footprint of the dredging, and organisms on the channel bottom will be removed. Local noise, physical movement, and vibration generated by the dredge may temporarily cause individuals to move out of adjacent habitat. Spill of petroleum products and suspension of sediment may occur during dredging. Contaminants introduced into the channel, including suspended sediment, may adversely affect

Table 3-3. Project Actions, Specific Project Activities, and Impact Mechanisms under Implementation of the SDIP

Project Actions	Specific Project Activities	Environmental Conditions Affected: ASIP-Covered Fish Species	Environmental Conditions Affected: ASIP-Covered Wildlife Species	Environmental Conditions Affected: ASIP-Covered Plant Species
Construct operable gates on Middle River, Grant Line Canal, and Old River at DMC; construct a fish control structure at head of Old River	▪ Grading of channel bank and dredge channel bottom at gate sites ▪ Construction of control gates, boat locks, and supporting structures across channel ▪ Placement of riprap on channel bank and bottom at gate sites ▪ Construction of sheetpile coffer dams to isolate construction areas; pumping of water from inside coffer dams (qn in-the-wet construction method may be implemented in place of cofferdams) ▪ Potential accidental spill of petroleum products ▪ Traffic noise and footprint disturbance	▪ Substrate: removal, disturbance, modification, and replacement of channel bottom and channel bank substrates ▪ Cover: removal and disturbance of aquatic and riparian vegetation; addition of hard structure to channel cross section ▪ Contaminants: potential spill of petroleum products and concrete; suspension of sediment during dredging, grading, and other construction activities ▪ Channel dimensions: change in channel depth and width ▪ Nonnative predator species: change in cover, depth, and velocity associated with gate structure—may alter habitat for nonnative species ▪ Physical contact: removal or crushing of organisms during dredging, grading, placement of riprap; entrainment of organisms with water pumped during evacuation of construction areas within coffer dams ▪ Disturbance: noise, physical movement, or vibration sufficient to cause movement of individuals from local habitat	▪ Physical injury: removal or crushing of organisms during gate construction; entrainment of organisms with water pumped during evacuation of construction areas within coffer dams ▪ Disturbance: noise, physical movement, or vibration sufficient to cause movement of individuals from local habitat, which may cause abandonment of active nest sites and the loss of fledglings ▪ Breeding and foraging habitat: permanent or temporary loss of breeding and foraging habitat	▪ Physical injury: removal of plants during dredging, grading, and placement of riprap ▪ Nonnative competitors: introduction or spread of nonnative plants that compete for suitable habitat ▪ Substrate: removal, disturbance, modification, and replacement of channel bank substrates
Operate gates on Middle River, Grant Line Canal, and Old River at DMC; operate a fish control structure at head of Old River	▪ Localized effects resulting from physical operation of gates; effects of water supply operations are covered under OCAP BO	▪ Gate: closure of control gates at head of Old River will block flow and fish movement; closure of other gates will block flow and fish movement during stages less than 0.0 feet above mean sea level ▪ Stage: operation of gate will maintain stage at 0.0 feet above mean sea level in channels on the upstream side of the gates and, potentially, intertidal area will be reduced slightly ▪ Flow velocity: operation of gate will affect circulation in channels on upstream and downstream sides of gates ▪ Net flow direction: depending on interaction between inflow and diversions, net flow direction may change in some channels ▪ Soil moisture: higher stage could increase soil moisture elevation on lands adjacent to affected channels ▪ Cover: change in stage could affect maintenance and establishment of riparian and aquatic vegetation, affecting availability of cover ▪ Contaminants: change in circulation may change residence time and volume and concentration of salts, pesticides, nutrients, and other materials from agricultural return flows ▪ Water temperature: change in circulation could change water temperature ▪ Dissolved oxygen: change in circulation could change dissolved oxygen levels ▪ Predator effectiveness: operation of gates could create feeding areas for predator species and hydraulic conditions that disorient prey ▪ Nonnative predator species: change in cover, depth, and velocity may alter habitat to favor nonnative species in channels between gates ▪ Food: change in residence time, combined with change in contaminants, may affect food production	▪ Disruption of migration corridors: closure of control gates will temporarily disrupt aquatic migration corridors	▪ Gate: closure of control gates will block flow and dispersal of plants ▪ Stage: operation of gate will alter low- and high-tide levels and could affect intertidal habitat ▪ Flow velocity: operation of gate will affect flow velocity and, possibly, amount of bank scour ▪ Salinity: change in circulation may change salinity of water

		Environmental Conditions Affected		
Project Actions	Specific Project Activities	ASIP-Covered Fish Species	ASIP-Covered Wildlife Species	ASIP-Covered Plant Species
Dredge West Canal, Old River, Middle River, and Grant Line Canal	▪ Grading and removal of vegetation to create staging area for dredge machinery and operation ▪ Removal and disturbance of channel bottom and channel bank substrate and vegetation (i.e., aquatic and riparian) along: ▪ Diversion of water for conveyance of dredged sediments (depends on dredge type) ▪ Potential accidental spill of petroleum products into the channel ▪ Change in channel conveyance capacity ▪ Disturbance and burial of terrestrial or aquatic communities at dredged material disposal sites and along routes to disposal sites ▪ Discharge of dredge conveyance water ▪ Traffic noise and footprint disturbance ▪ Construction and use of sediment staging and disposal areas	▪ Channel dimensions: increase in channel depth and width; potential for ongoing changes to channel dimensions and potential loss of existing shallow area ▪ Substrate: removal, disturbance, and mobilization of channel bottom and channel bank substrates; potential for ongoing erosion of shallow areas as a result of changes in channel dimensions ▪ Cover: removal or disturbance of aquatic and riparian vegetation; potential for ongoing loss of riparian and aquatic vegetation as a result of channel bank erosion ▪ Contaminants: release of petroleum products from construction equipment; suspension of sediment by construction activities; mobilization of contaminants from channel sediments ▪ Stage: change in channel dimensions may affect stage ▪ Flow velocity: change in channel dimensions may change velocity ▪ Nonnative predator species: change in cover, depth, and velocity may alter species habitat ▪ Physical contact: removal or crushing of organisms during dredging and disposal of dredge spoils	▪ Physical injury: removal or crushing of organisms during dredging operations; entrainment of organisms with water pumped during dredging ▪ Disturbance: noise, physical movement, or vibration sufficient to cause movement of individuals from local habitat, which may cause abandonment of active nest sites and loss of fledglings ▪ Breeding and foraging habitat: permanent or temporary loss of breeding and foraging habitat	▪ Physical injury: removal of plants during dredging ▪ Nonnative competitors: introduction or spread of nonnative plants that compete for suitable habitat at dredge disposal sites ▪ Substrate: removal, disturbance, modification, and replacement of channel bank substrates

DMC = Delta-Mendota Canal.
OCAP = Operations Criteria and Plan.
BO = biological opinion.

organisms, causing mortality from acute toxicity and suffocation of fish eggs and sessile organisms.

Dredging will increase the conveyance capacity of the channel. Tidal flow velocity may be slightly reduced in West Canal and, depending on existing channel constrictions, circulation may be increased in Middle River, Old River, and Grant Line Canal.

3.3.3 Overview of Permanent and Temporary Impacts

The project would have an adverse impact on fish, wildlife and plant species if project activities would result in the loss or disturbance of organisms and habitat or reduce habitat quality. The SDIP would result in short-term and long-term impacts on natural communities in the project area. Implementation of the SDIP affects a range of environmental conditions (Table 3-3).

The SDIP would result in temporary and permanent impacts on vegetation and wetland resources in the project area. In assessing the magnitude of possible impacts, the following project assumptions and assumptions were made regarding construction, gate operations, and maintenance activities.

Temporary impacts would be those that occur during the construction and dredging periods and where the baseline land cover type will be restored following construction. Temporary impacts include the following categories.

- Temporary impact areas at each gate site caused by equipment staging and equipment movement would include the temporary staging areas, any new temporary access roads, and the area within the temporary construction easement. Impacts would occur only during construction.
- Hydraulic dredging would occur in West Canal, Middle River, and Old River (Figures 2-5–2-7). Hydraulic dredges draw water and substrate into a flexible pipe and transport the material through a stationary pipe that extends up the levee face and over the levee.
- Sealed clamshell dredging would occur either from barges or the levee top at the gate site. Dredge material would be transported to a barge or over the levee in the bucket attached to the arm of the dredge.
- Temporary impacts of initial hydraulic dredging at gate sites would include placement of dredge disposal pipelines on the channel bank. Hydraulic dredge spoils would be transported through pipes placed over the levee to spoils ponds and may affect levee vegetation. Placement of dredge spoil pipes would avoid vegetation wherever possible, but all avoidance may not be possible. Initial and maintenance dredging at gate sites would disturb up to 150 feet upstream and 350 feet downstream of the each gate. Dredging of each upstream and downstream area is assumed to require two crossings of

the levee face, for a total of 16 crossings; it is also conservatively assumed that each pipe crossing would require removal of vegetation in a 10-foot-wide strip across the levee face. Assuming removal of vegetation in a 10-foot-wide strip for placement of each of the six stationary pipes and an estimated levee face height of 15 feet, there would be removal of up to 0.003 acre (150 square feet) of woody riparian vegetation at each crossing. The exact locations of stationary pipes to transport dredge material over the levees to spoils ponds at the three flow control gate sites are currently unknown, but DWR and Reclamation would avoid placing pipe in woody riparian vegetation to the extent possible. This impact would continue until the banks were revegetated. Temporary impacts of hydraulic channel dredging in West Canal, Middle River, and Old River (Figures 2-5–2-7) would be similar to impacts at gate sites and would include locations where dredge disposal pipelines extend across the levee face. Vegetation would be removed for placement of pipes on the levee face at up to four crossings on West Canal, up to eight crossings on Middle River, and up to two crossings on Old River, for a total of 14 crossings. Assuming removal of vegetation in a 10-foot-wide band for placement of each of the six stationary pipes and an estimated levee face height of 15 feet, there would be removal of up to 0.003 acre (150 square feet) of woody riparian vegetation at each crossing. The exact locations of stationary pipes to transport dredge material over the levees to spoils ponds at the three flow control gate sites are currently unknown, but DWR and Reclamation would avoid placing pipe in woody riparian vegetation to the extent possible.

The extent of dredge areas would affect up to:

- 40 other acres for one temporary spoils pond on Widdows Island for the West Canal dredge area;
- 165 other acres for ponds on Union Island, Roberts Island, or Stewarts Tract for Middle River and Old River; and
- 1.5 acres for ponds associated with or in the vicinity of each of the gate sites.

Preliminary locations of the temporary spoils ponds have been identified, and DWR has mapped land cover types in the basin footprints (Figure 2-8). DWR has committed to constructing all ponds or basins on agricultural land and ruderal lands adjacent to the dredge operations and to avoiding sensitive habitats, including wetlands and occurrences of special-status species. It is assumed that construction, operation, and removal of the basins will not affect adjacent sensitive resources or land cover types, including (i.e., not limited to) wetlands, other waters of the United States, riparian habitat, and valley elderberry longhorn beetle (VELB) habitat. These ponds or basins would remain in use for up to 5 years and would then be returned to agricultural use.

- Intertidal areas could experience changes in hydrologic regime during project operation that would result in temporary impacts while the vegetation adapts to the new regime.

- A 6- to 12-inch layer of dredge material would be placed on portions of the unvegetated areas on the landside of the levees for levee reinforcement. The placement of dredge material would be in accordance with the avoidance measures described in Chapter 2.

Permanent impacts include changes from vegetated to developed areas. The permanent impact areas for each gate site and dredge area would include the following.

- Construction of permanent gates and related facilities (e.g., control structures, parking areas, maintenance yards, permanent access roads) will result in the loss of vegetation and potential increase in impervious surfaces.
- The placement of levee slope protection upstream and downstream of the gates will result in the fill of wetland and tidal perennial aquatic habitat and the loss of vegetation in the footprint of the slope protection areas.
- Dredging would occur as part of project construction. It is assumed that hydraulic dredging would not affect any vegetation on the levee face (beyond the initial disturbance from dredge disposal pipelines).
- During gate operation, changes in water elevation of more than 1 foot would result in a measurable gain or loss of tidal perennial aquatic habitat and inundation or stranding of emergent wetland vegetation. Water elevation changes of less than 1 foot could have measurable impacts on intertidal special-status plants as a result of the loss of available habitat.
- Gate operations would increase the period of open channel conditions and benefit fish passage and migration in south Delta channels. Closure of the head of Old River fish control gate would improve migration conditions for Chinook salmon (juvenile migration in spring, adult migration in the fall). However, changes in flow patterns associated with the gate operations could potentially increase the movement of Delta smelt juveniles from the central Delta towards the CVP and SWP pumping facilities.

3.3.4 Overview of Impact Assessment Methods for ASIP-Covered Fish Species

The impacts of channel- and channel bed–disturbing activities associated with gate construction, gate operation, and channel dredging and the implementation of mitigation sites (if applicable) are assessed in the ASIP. The purpose of this section is to explain the methods used in this ASIP to determine impacts associated with gate construction, operation of the gates, and channel dredging.

3.3.4.1 SDIP Assessment Methods

This section summarizes the assessment methods used in this ASIP to determine impacts associated with gate construction, gate operation, and channel dredging. Habitat requirements that are addressed in this assessment of impacts on fish include spawning habitat quantity, rearing habitat quantity, migration habitat condition, water temperature, and food. Assessment methods are generally species and life stage specific. Entrainment in diversions is not addressed in this ASIP but is addressed under OCAP. However, the potential indirect effects of gate operations on net flows in the south Delta that may increase the entrainment of delta smelt from the central Delta are generally evaluated.

Assessment of Change in Spawning Habitat Quantity

ASIP-covered salmonids do not spawn in the south Delta; therefore, gate construction, gate operation, and activities associated with channel dredging would not affect spawning habitat for these species.

Delta smelt spawn in the Delta. The assessment of project impacts on spawning habitat considered the total area to be affected by project implementation.

Green sturgeon spawn in the Sacramento River downstream of Shasta Dam and may occur in other Central Valley rivers. Therefore, gate construction, gate operation, and activities associated with channel dredging would not affect spawning habitat for these species.

Assessment of Change in Rearing Habitat

Fall-/late fall–run, Central Valley spring-run, and Sacramento River winter-run Chinook salmon; delta smelt; and splittail rear in the Delta. Gate construction and operations have the potential to permanently modify shallow vegetated areas that may provide rearing habitat for Chinook salmon. Channel dredging could have a temporary impact on rearing habitat. The assessment of project impacts on rearing habitat for salmon and smelt considered the total area to be affected by project implementation.

Steelhead rear primarily in natal reaches upstream of the Delta (McKewan and Jackson 1996), and the current importance of rearing habitat in the Delta is unknown. Project impacts on rearing habitat for steelhead would be the same as those used for Chinook salmon.

Green sturgeon are mostly marine fish that migrate into rivers to spawn. Early life stages may spend up to 2 years in fresh water (Moyle 2002). Juveniles inhabit the estuary until they are approximately 4–6 years old and then migrate to the ocean (Kohlhorst et al. 1991). Little is known about the movements and habits of green sturgeon. It is assumed that they will migrate throughout the

Delta and rivers during any time of the year; therefore, they could be present in the study area.

Assessment of Change in Migration Habitat Conditions

The assessment of project impacts on migration habitat conditions for ASIP-covered fish species includes a discussion of temporary impacts of gate construction and channel dredging and the permanent impacts of gate operations. The assessment also includes a description of gate operations and windows of time when the gates would be operated.

Assessment of Change in Food Availability

Many of the same factors affecting spawning and rearing habitat area would be expected to affect food production and availability for juvenile salmonids as well as delta smelt. Construction of the gates in the south Delta and maintenance activities have the potential to permanently modify shallow vegetated areas by removing rooting substrate. Channel dredging would not result in the removal of tule and cattail tidal emergent wetland but may result in temporary impacts on aquatic vegetation.

Assessment of Change in Water Temperature

The assessment for each ASIP-covered fish species in Chapter 5 addressed the potential for project impacts on water temperature. As stated in Chapter 5, gate construction, gate operation, and channel dredging will not affect water temperature in the Delta and therefore will not affect ASIP-covered fish species.

Assessment of Changes in Other Environmental Correlates

Gate construction, gate operation, and activities associated with channel dredging have the potential to affect several other environmental correlates in the project area, including introduction of contaminants, injury to ASIP-covered fish species, increased entrainment associated with changes in south Delta circulation, and increased predation. The impacts of the project on the other environmental correlates are addressed in Chapter 5.

3.3.5 Overview of Impact Assessment Methods for ASIP-Covered Wildlife Species

The analysis of project-related impacts on ASIP-covered wildlife species is based on:

- the most current proposed project, as developed by DWR;
- existing biological resource and current (as of 2000–2001 and 2003 field surveys) baseline conditions;
- habitat mapping provided by DWR;
- field surveys and literature reviews performed by DWR;
- a review of the CNDDB (January 2005); and
- a species list provided by the USFWS (November 2004) (Appendix B).

The CNDDB search included all USGS quadrangle maps in which the project area is located (California Natural Diversity Database 2004): the Woodward Island, Holt, CCF, Union Island, Lathrop, and Stockton West 7.5-minute quadrangles. The CNPS inventory review included special-status species that occur or may occur in Contra Costa and San Joaquin Counties. The USFWS species list included special-status species that occur or may occur in Contra Costa and San Joaquin Counties. Specific information pertaining to field surveys and literature reviews performed and provided by DWR are provided in the individual species assessments in Chapter 5 and in the species accounts provided in Appendix B.

3.3.6 Overview of Impact Assessment Methods for ASIP-Covered Plant Species

The impact assessment for special-status plants used one of two approaches, depending on the species: its likelihood of occurrence in the project area or its regulatory status.

The impact analysis for plant species not found during the 2000–2001 surveys but with suitable habitat in the project area was developed in a narrative form. A conceptual model was developed for intertidal species (Mason's lilaeopsis), to document the logical steps used in the impact analysis. Additional information pertaining to surveys performed for each species is provided in Chapter 5.

3.3.6.1 Plant Species Assessment Model

Assessment of project impacts using the species assessment model considers the occurrence of each life stage of the species (i.e., plant establishment, plant growth and maintenance, and dispersal [Table 3-4]). Environmental correlates addressed in this assessment of impacts on intertidal plants include continuity, entrainment, contaminants, key habitat quantity, scour, physical injury, and competition (Figure 3-3 and Table 3-5). The assessment is life stage specific. For example, the environmental correlates affecting dispersal of intertidal plants include continuity (of habitat) and entrainment. Environmental correlates would be affected by environmental conditions that may be altered by the project, including placement and operation of the permanent gates, proposed water diversions, and flow velocity, stage, and pattern in the channels during gate operation.

The life stages of establishment, growth, and maintenance of intertidal plants are affected by other environmental correlates, including contaminants, key habitat quantity, scour, physical injury, and competition. The environmental conditions affecting this set of correlates include tidal elevation, substrate, water salinity, nonnative competitors, gate construction, and flow velocity.

Hypotheses of the species' responses to variation in environmental correlates are identified for applicable species' life stages and are translated into models that indicate the species' responses (Table 3-6). The response of each species to change in environmental correlates is determined by the ecology and physiology of a species' life stage. The hypotheses presented in Table 3-6 apply to all four species, except where individual species are mentioned.

Table 3-4. Life Stages of ASIP-Covered Intertidal Plants

	Life Stage				
Species/Life Form	Seed Dispersal	Propagule Dispersal	Plant Establishment	Vegetative Growth	Reproduction (Blooming Period)
Mason's lilaeopsis (perennial herb; rhizomatous)	May–December	Year-round	Year-round	Year-round	April–November

Table 3-5. ASIP-Covered Plants: Assumptions for Selected Environmental Correlates

Environmental Correlate	Mason's Lilaeopsis
Key Habitat Quantity	
Substrate	Clay or clay loam, occasionally with significant amounts of silt or sand (Fiedler and Zebell 1993)
Salinity (tidally generated)	0.25–8.5 ppt (Fiedler and Zebell 1993)
Elevation	Approximately 0.5–2 feet NGVD (mean 0 tide level) (California Department of Fish and Game 1995b; California Department of Water Resources 2001)
Flow velocity (erosion)	Not documented, but some level of erosion is assumed to be beneficial
Competitors	Sites that support few or no competitors are more likely to support this species; larger species may require a more stable substrate (Fiedler and Zebell 1993)
Scour	Not documented, but some level of scour is assumed to be beneficial; higher velocities would be needed to remove mature plants than seedlings; scour velocities are also substrate-dependent (e.g., sandy banks are more susceptible than clay banks)
Contaminants	Nontidal salinity and herbicides would adversely affect the species Lethal concentrations are unknown Project is assumed not to include changes in waterborne contaminants; however, direct application of herbicides for levee maintenance would adversely affect this species
Competition	Unknown, but observed to include *Schoenoplectus acutus*, *Juncus effusus* var. *pacificus*, and *Iris pseudacorus* (Witzman pers. comm.)

NGVD = national geodetic vertical datum.
ppt = parts per thousand.

3.4 Assessment of Impacts on Natural Habitats

The analysis of project-related impacts on natural communities is based on the most current proposed project, as developed by DWR, and community mapping provided by DWR.

3.4.1 Natural Community Surveys

Natural communities were mapped throughout the study area in the vicinity of the permanent gates, the channel dredging areas, and waterways in the vicinity of these areas that may be affected by gate construction and channel dredging (Figure 1-1). DWR botanists mapped and characterized representative sites for the major land cover types in the SDIP area of impact. Large representative stands of the dominant vegetation types were selected at sites throughout the study area. The vegetation was described (species composition and cover), and

Environmental Correlates	Hypotheses for Species Response	Responsiveness	Level of Certainty	Discussion	Measure of Impacts	Explanation
Seed/Propagule Dispersal						
Continuity	Flow patterns, velocities, stage, and hydrologic connections between habitat areas during seed/propagule dispersal periods dictate the dispersal of seeds/propagules throughout the SDIP study area and, therefore, the ability of species to colonize unoccupied habitat.	Low	Low	Responsiveness is assumed to be minimal because the availability of habitat is believed to be the primary factor limiting species distribution (i.e., improving or reducing the dispersal of seeds/propagules in the SDIP study area would be unlikely to change distribution because unoccupied habitat available for plant establishment is limiting) (California Natural Diversity Database 2004). Existing use of temporary barriers already limits transport of seeds/propagules within the project area. The level of certainty is considered low because, although it is generally accepted that flow is the primary dispersal mechanism, the relationship among flow pattern, velocities, and stage during dispersal periods and plant establishment potential throughout the SDIP study area is unknown.	Change in channel flows	Qualitative assessment of likely effects of changes in channel flow characteristics (from hydrology model results) on seed/propagule dispersal and probable effects on future distribution of occurrences in the SDIP study area.
Entrainment	Probability for entrainment of seeds/propagules during dispersal periods increases in proportion to diversion volume.	Unknown	Low	Responsiveness is assumed to be minimal because the availability of habitat is believed to be the primary factor limiting species distribution (i.e., improving or reducing the dispersal of seeds/propagules in the SDIP study area would be unlikely to change distribution because unoccupied habitat available for plant establishment is limiting) (California Natural Diversity Database 2004).	Change in diversion volume	Qualitative assessment of likely effects of changes in diversion volume on seed/propagule dispersal and probable effects on future distribution of occurrences in the SDIP study area.
	Gates present during seed/propagule dispersal periods prevent colonization of unoccupied habitat below the gates from seed/propagule sources upstream of gates.	Low	Low	The level of certainty is considered low because, although it is generally accepted that flow is the primary dispersal mechanism, the relationship between the proportion of seeds/propagules produced that are entrained and plant establishment potential throughout the SDIP study area is unknown.		Qualitative assessment of likely effects of changes in channel flow characteristics (from hydrology model results) on seed/propagule dispersal and probable effects on future distribution of occurrences in the SDIP study area.
Plant Establishment						
Key Habitat Quantity	The probability for establishment of plants is limited by the extent of suitable habitat in the SDIP study area.	High	Low	Responsiveness is assumed to be high because the availability of suitable habitat is believed to be the primary factor limiting species distribution (California Natural Diversity Database 2004). Tidal wetlands, much of which include the intertidal zone where species habitat is located, are estimated to have declined by 95% from prereclamation conditions (CALFED Bay-Delta Program 2000b). The level of certainty is considered low because, although it is generally accepted that species occurrence and distribution in the Delta have declined substantially as a result of habitat loss, the relationship between changes in the extent of habitat and the likelihood of establishment of plants is unknown. Mason's lilaeopsis has been successfully transplanted (McCarten 1990) and may readily establish on suitable habitat.	Change in salinity (tide-generated), stage frequency, flow velocity, channel form, competitor plant species abundance, and extent and type of substrate	Quantitative assessment of effects of changes in salinity (tide generated), stage frequency, and flow velocity (based on water quality and hydrology modeling results) expressed as linear feet of habitat. Adverse effects on habitat or directly on the species would be assumed where predicted changes in these environmental conditions exceed the known or estimated tolerances of the species. Based on results of sediment transport and hydrology modeling results, qualitative assessment of effects of changes in extent of suitable substrate on the extent of sites suitable for plant establishment. Qualitative assessment of changes in erosion/deposition patterns and scour potential that could result from changes in channel form (e.g., dredging) on the extent of sites suitable for plant establishment. Qualitative assessment of likely changes in competitor plant species abundance (i.e., colonization of habitat disturbed as a result of project actions, on the extent of habitat available for plant establishment).

Environmental Correlates	Hypotheses for Species Response	Responsiveness	Level of Certainty	Discussion	Measure of Impacts	Explanation
Physical Contact	Probability of survival of establishing plants decreases with increases in ground disturbance–related activities conducted in occupied habitat (i.e., levee maintenance, recreational, and other activities that could result in the direct removal, trampling, burying, or other physical disturbance to plants).	High	High	Responsiveness is assumed to be high because physical disturbance of establishing plants could result in loss of plants, thus reducing distribution and abundance in the SDIP study area. The level of certainty is considered high because loss of plants to physical disturbances is a known threat to most rare plant species. Mats of algae and water hyacinth treated with herbicide can accumulate and bury small intertidal plants such as Mason's lilaeopsis (Witzman, pers. comm.; California Department of Boating and Waterways 2001.)	Change in frequency and extent of ground-disturbing activity	Qualitative assessment of likely changes in the type, magnitude, and extent of ground-disturbing activities (e.g., gate construction area, level of recreation-related activity, levee maintenance, and dredging requirements) that could reduce survival of establishing plants.
Scour	Substantially increased flow velocities are assumed to be sufficient to scour newly establishing plants from sites and, thus, preclude establishment of individuals and new occurrences.	High	Low	Responsiveness is assumed to be high because flow velocities sufficient to scour establishing plants from sites would result in loss of plants, thus reducing distribution and abundance in the SDIP study area. The level of certainty is considered low because, although it is well understood that flow can scour plants from sites, the specific tolerances of establishing plants under various site conditions (e.g., substrate, channel form) to scour at given flow velocities are unknown.	Change in flow velocity during plant establishment periods	Qualitative assessment of effects of changes in flow velocities and scour potential on survival of establishing plants (based on hydrology modeling results).
Competition	Movement of other plant species into suitable habitat reduces the ability of the covered intertidal plants to become established.	High	Low	Responsiveness is assumed to be high because establishment of other species, particularly nonnative species, in suitable habitat could prevent seed germination or seedling growth (e.g., shading, loss of nutrients, allelopathy). The level of certainty is considered low because, although the establishment and spread of nonnative plants in the Delta are generally accepted as deleterious to the Bay-Delta ecosystem, the specific effects of the establishment of nonnative plants in occupied sites have not been reported for the species under consideration.	Change in abundance of competitor plant species	Qualitative assessment of likely changes in competitor plant species abundance as a result of project actions and potential effects on plant establishment in suitable habitat (Table 3-5).
Contaminants	Contaminant input reduces the likelihood of survival of establishing plants. The responsiveness of each species is relative to contaminant type and the expected concentration of contaminants or mixtures of contaminants.	High	Medium	Although the responsiveness of intertidal plants to all contaminants present in the SDIP study area is unknown, species could be adversely affected by windborne spray drift of herbicides or by contact with herbicide residues in the channel water during high tide. Herbicides potentially toxic to intertidal plants include Weedar 64, Reward, Rodeo, and Sonar. Mats of water hyacinth killed by herbicides and washed onshore could smother Lilaeopsis and Limosella (California Department of Boating and Waterways 2000, 2001.) The level of certainty is considered medium because, although certain contaminants may adversely affect plants, the timing and duration of exposure, type, and concentration of contaminants that could result in harming plants are unknown.	Change in contaminant concentration by type	Qualitative assessment of likely effects of changes in contaminant loadings on survival of establishing plants.
Vegetative Growth and Reproduction						
Key Habitat Quantity	A reduction in the extent of occupied habitat reduces the abundance of plants over time.	High	High	Responsiveness is assumed to be high because a reduction in the number of plants reduces the current abundance and the production and availability of seeds and propagules. Therefore, the probability of natural colonization of unoccupied habitat in the vicinity of affected occurrences results from the reduced availability of seeds/propagules. The level of certainty is considered high because a reduction in individuals results in a loss of reproductive potential.	Change in salinity (tide-generated), stage frequency, flow velocity, channel form, and extent of habitat	Quantitative assessment of effects of changes in salinity (tide-generated), stage frequency, and flow velocity (based on water quality and hydrology modeling results) expressed as linear feet of affected occupied habitat. Adverse effects on habitat or directly on the species would be assumed where predicted changes in these environmental conditions exceed the known or estimated tolerances of the species. Quantitative assessment of the extent of occupied habitat directly removed by project actions (i.e., footprint of gates and levee improvements). Qualitative assessment of changes in erosion/deposition patterns and scour potential that could result from changes in channel form (e.g., dredging) on the extent of occupied habitat.

Environmental Correlates	Hypotheses for Species Response	Responsiveness	Level of Certainty	Discussion	Measure of Impacts	Explanation
Physical Contact	Probability for survival of plants and occurrences decreases with increases in ground disturbance–related activities conducted in occupied habitat (i.e., gate construction, levee maintenance, recreation, and other activities that could result in the direct removal, trampling, burying, or other physical disturbance to plants).	High	High	Responsiveness is assumed to be high because physical disturbance of establishing plants could result in loss of site occurrences, thus reducing distribution and abundance in the SDIP study area. The level of certainty is considered high because loss of plants to physical disturbances is generally accepted.	Change in abundance	Quantitative assessment of effects of actions that result in ground disturbance on the number of occurrences. Measure of effects will be expressed as change in number of occurrences, proportion of all known occurrences affected by project actions, and, if possible, estimated number of affected individuals.
Scour	Substantially increased flow velocities could scour established plants from sites. The velocity threshold for this response would be lower for Lilaeopsis and Limosella than for the Hibiscus and Lathyrus.	Medium–high	Low	Responsiveness is assumed to be high because flow velocities sufficient to scour established plants from sites would result in loss of plants, thus reducing distribution and abundance in the SDIP study area. The level of certainty is considered low because, although it is well understood that flow can scour plants from sites, the specific tolerances of established plants under various site conditions (e.g., substrate, channel form) to scour at given flow velocities are unknown.	Change in flow velocity during plant establishment periods	Qualitative assessment of effects of changes in flow velocities and scour potential on survival of established plants (based on hydrology modeling results.
Competition	Movement of other plant species into occupied habitat reduces survival of established Lilaeopsis and Limosella plants.	High	Low	Responsiveness is assumed to be high because establishment of other species, particularly nonnative species, in occupied habitat could displace plants (e.g., shading, loss of nutrients, allelopathy). The level of certainty is considered low because, although the establishment and spread of nonnative plants in the Delta are generally accepted as deleterious to the Bay-Delta ecosystem, the specific effects of the establishment of nonnative plants in occupied sites have not been reported for the species under consideration.	Change in abundance of competitor plant species	Qualitative assessment of likely changes in competitor plant species abundance as a result of project actions and potential effects on established plant survival.
Contaminants	Contaminant input reduces plant survival. The responsiveness for each species is relative to contaminant type and the expected concentration of contaminants or mixtures of contaminants.	High	Medium	Although the responsiveness of intertidal plants to all contaminants present in the SDIP study area is unknown, species could be adversely affected by windborne spray drift of herbicides or by contact with herbicide residues in the channel water during high tide. Herbicides potentially toxic to intertidal plants include Weedar 64, Reward, Rodeo, and Sonar. Mats of water hyacinth killed by herbicides and washed onshore could smother Lilaeopsis and Limosella. (California Department of Boating and Waterways 2000, 2001.) The level of certainty is considered medium because, although certain contaminants may adversely affect plants, the timing and duration of exposure, type, and concentration of contaminants that could result in harming plants are largely unknown.	Change in contaminant concentration by type	Qualitative assessment of likely effects of changes in contaminant loadings on survival of established plants.

the location was recorded with a GPS unit. These representative sites were mapped directly onto ortho-rectified, georeferenced aerial photographs of the area (September 1, 2000, 1:2,400 scale, acquired at low tide). The aerial photographs were used to classify and map riparian/streamside vegetation. Acreages were either calculated from the GIS data or were planimetered from the aerial photographs.

In August and September 2001 and June and July 2003, DWR staff conducted a wetland delineation of most of the project area according to the methods outlined in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). In November 2004, Jones & Stokes staff conducted a wetland delineation of the potential spoils pond areas. Other waters of the United States, including tidal perennial aquatic habitat, were identified based on the definition of waters of the United States (33 CFR Part 328).